FTD-HT-66-540

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NEW POLYMERIC MATERIALS IN ANTICORROSION TECHNOLOGY

by

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50 YEARS
1917 1967
GOLDEN ANNIVERSARY
FOREIGN TECHNOLOGY DIVISION

18

FTD-HT- 66-540

UNEDITED ROUGH DRAFT TRANSLATION

NEW POLYMERIC MATERIALS IN ANTICORROSION TECHNOLOGY

By: I. Ya. Klinov

English pages: 13

SOURCE: Trudy. Vsesoyuznoy Mezhvuzovskoy Nauchnoy Konferentsii po Voprosam Bor'by s Korroziyey. (Transactions of the Inter-Higher Educational Institute Scientific Conference on Questions of Fighting Corrosion), Moskva, Gostoptekhizdat, 1962, pp. 296-303.

Translated by: L. Marokus/TDBXT

TT6001757

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ITIS INDEX CONTROL FORM

01 Acc Nr	68 Translation Nr	65 X Ref Acc Nr	76 Reel/Frame Nr
TT6001757	HT6600540		1654 [illegible]

97 Header Clas	63 Clas	64 Control Markings	94 Expansion	40 Ctry Info
UNCL	UNCL, 0	0		UR

02 Ctry	03 Ref	04 Yr	05 Vol	06 Iss	07 B. Pg.	45 E. Pg.	10 Date
UR	0000	62	000	000	0296	0303	NONE

Transliterated Title
NOVYYE POLIMERNYYE MATERIALY V ANTIKORROZIONNOY TEKHNIKE

09 English Title
NEW POLYMERIC MATERIALS IN ANTICORROSION TECHNOLOGY

43 Source AZERBAYDKHANSKIY ORDENA TRUDOVOGO KRASNOGO ZNAMENI INSTITUT NEFTI I KHIMII "VSESOYUZNOY MEKHVUZOVSKOY NAUCHNOY KONFERENTSII PO VOPROSAM BOR'BY S KORROZIYEY" *

42 Author	98 Document Location
KLINOV, I. YA.	
16 Co-Author NONE	**47 Subject Codes** 11
16 Co-Author NONE	**39 Topic Tags:** corrosion, nonferrous metal, high alloy steel, stainless steel, epoxy resin, nylon
16 Co-Author NONE	
16 Co-Author NONE	

ABSTRACT: The article enumerates several kinds of plastic materials which are suitable for use in combatting corrosion, and several which have suitable strength characteristics as to serve in place of scarce expensive metals and alloys. Included are vinyl for piping, sheet graphite for parts of heat exchangers, liquid "Nairit" (chloroprene rubber) for anticorrosion protection of ship propellers. Plastics have also been used successfully tc fabricate parts of armatures. Plastics of fluorocarbonic compounds have been found expecially chemically stable, resisting ever fuming nitric acid and aqua regia. Polyorganosiloxanes have proven their value in preventing corrosion. Fiberglass has also found many uses in industrial plant installations. Epoxy resins, epoxy lacquers, nylon and other compounds are also described and examples given of their successful application. English translation: 13 pages.

* 43. additional information: (RUSSIAN)

FTD Form Feb 67 0-90

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* <u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

NEW POLYMERIC MATERIALS IN ANTICORROSION TECHNOLOGY

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In recent years many branches of national economy for the struggle with corrosion are finding broad application, nonmetallic, chemically stable materials, obtained on the basis of polymers, in form of individual structural materials or linings, protective coatings, coatings, etc.

These materials are used for the purpose of economizing on nonferrous metals and highly alloyed steels, used by various industries in the role of anticorrosion materials. And so, at the Derbenevsk chemical plant, where many kilometers of pipes were laid from sheet vinyl with a diameter of from 1/2 to 5, as a result of replacing lead and stainless steel were economized about 30,000 rubles. At the Akrikhin plant during the preparation of only one heat exchanger, new sheet graphite materials were economized 10 t of lead, during the preparation of another apparatus – 6 t of lead and 5 t of stainless steel; the new anticorrosion coating for the protection of details from ferrous metals – liquid Nairit (chloroprene rubber) – allows us to use these materials widely for the replacement of deficit metals

in various branches of national economy. This coating was tested, especially, in ship construction and for the protection of screws (propellers), subjected not only to corrosion, but to erosion and cavitation, in thermal power equipment, etc. The Mysheg armature plant manufactures armature details, lined with rubber, polyethylene, faolite, etc. The use of armature from plastics assured, in particular, a considerable economy in bronze in gear wheels of electric drives.

The modern level development of chemical, petroleum industry, nuclear and high-temperature technology does not allow us in many cases to realize technological processes taking place in sharply aggressive conditions, even with the use of nonferrous metals, stainless steel, titanium and other deficity and expensive metal materials.

It is possible to overcome the mentioned difficulties, if nonmetallic structural materials are used. It is impossible, for example, to represent modern methods of obtaining synthetic hydrochloric acid, a whole series of chloroorganic compounds, synthetic alcohol and others with the use of nonmetallic materials in machinery and construction.

The use of nonmetallic material is in many cases hindered by the inherent deficiencies to them: impossibility of preparing some noncumbrous constructions, low heat conductivity of others does not allow us to use the same in a heat exchange apparatus, low thermal stability of third ones make them unsuitable for the process, where a sharp change in temperature, etc., is possible. The difficulties in the use of nonmetallic materials, due to these reasons, have been presently overcome to a large degree. Right now there are materials possessing very high chemical stability to a majority of aggressive

media, high heat conductivity, strength, approaching the strength of metal, and other valuable properties; certain materials have a low specific weight, they submit to mechanical treatment, welding. They are all, obtainable mainly on the basis of organic products, suitable not only for the preparation of independent structures, but also for the lining of devices and equipment, and also in the role of compositions and protective coatings.

Polymeric materials possessing a practically unlimited chemical stability exceeding even platinum, appear to be plastics, obtained on the basis of fluorocarbonic compounds, which can be used as independent and lining materials, and also in the role of coatings.

The polytetrafluoroethylene or fluoroplast-4 plastics manufactured in the USSR suffer no destruction under the effect of almost all known aggressive media, including such strong oxidizers as fuming nitric acid, aqua regia, at temperatures of up to 250°C.

Fluoroplast-4 is not void of very essential specific deficiencies: its adhesion to metals and other materials is inconsiderable, which limits its utilization for the lining of devices. Its use for coating is difficult in connection with the insolubility of polytetrafluoroethylene neither in any one of the known organic solvents.

True, in recent years there has already been adopted a method of gluing on fluoroplast-4 to a metal surface by a specially developed technology. This allows wide use of fluoroplast-4 not only for pipes and hoses, but also as a lining material.

The application of coatings to their fluorocarbon compounds is possible from suspensions prepared on the basis of fluoroplast-3. To obtain such coatings connected with a complex condition of thermal

processing - it is necessary to apply it in sequence 12-15 layers. New methods of modifying fluoroplast-3 enables considerable simplification of the thermal process and to eliminate multilayer coatings. To obtain a fluoroplast-3M (modified) coating with a thickness of 250 μ is necessary to apply a total of 5 layers. In addition, the films do not crack and are suitable up to a temperature of 150°C in reaction conditions of sharply aggressive media.

The technology of applying coatings from fluoroplast-3M is analogous to the technology of applying coatings from fluoroplast-3. On the cleaned, sand blasted, defatted and desiccated surface of the metal is applied a layer of alcohol 30%-suspension of fluoroplast-3M. The coating is desiccated at first in air then at 120°C for a period of 20 min, and the melting of the polymer layer is carried out in a thermostat at 260°C within a period of 20-60 min depending upon the overall dimensions of the object.

To protect against corrosion it is necessary to apply a coating with a thickness of 250-400 μ.

As is known, a majority of polymeric materials are suitable to a temperature of not more than 150°C, and many of them of up to 40-50°C (vinylplast, polyisobutylene, etc.).

To a number of polymers possessing high heat resistance for preservation of their anticorrosion qualities and mechanical strength, belong so-called polyorganosiloxanes. Polyorganosiloxane coatings are stable also to the effect of oxygen, ozone, humid atmosphere, ultraviolet rays, etc., and in combination with various fillers (powderous aluminum, titanium, boron, etc.) up to 500-550°C and briefly to 700-800°C. Polyorganosiloxane coatings are suitable for the protection against corrosion of smoke pipes, pumps for pumping hot liquids, cracking installations and other equipment, working

under conditions of high temperatures and under the action of aggress've media. This reputation is used by the manufactured in the USSR polyorganosiloxane enamels No. 9 and enamel K-1. The first one is suitable for temperatures of up to 450-550°C, and the second to 350-400°C. The new types of aluminum enamels developed in the USSR hold out for a short time at a temperature of 600°C without any substantial change in outer form.

Graphite – the sole structural material possesses not only inertia to a majority of aggressive media, but also high heat conductivity and well mechanical properties. Consequently the use of graphite is especially effective at structural formation of heat exchange devices intended for operation under effective conditions of such aggressive media, as hydrochloric acid, phosphorous, hydrofluoric, etc., for which known and economically accessible metals and even special alloys are unsuitable. Use for this purpose of silicate materials is inadvisable because of low heat conductivity.

In cases when the materials cannot or should not be heat conductive and other requirements are facing it (high thermal stability at sharp temperature changes, inertia to aggressive media and a temperature rise, etc.), carbon is used.

The basic deficiency of carbon graphite materials – their porosity reaches up to 30-35%. To eliminate this porosity and to obtain an impermeable material, the graphite (also carbon) is saturated with various pore filling substances, which by themselves possess an inertia to aggressive media. In the USSR most investigated was the process of impregnating graphite with phenolformaldehyde tars.

As a result of saturating the graphite, its mechanical strength rises and porosity decreases considerably. Heat conductivity of the

saturated graphite in comparison with nonsaturated remains practically unchanged.

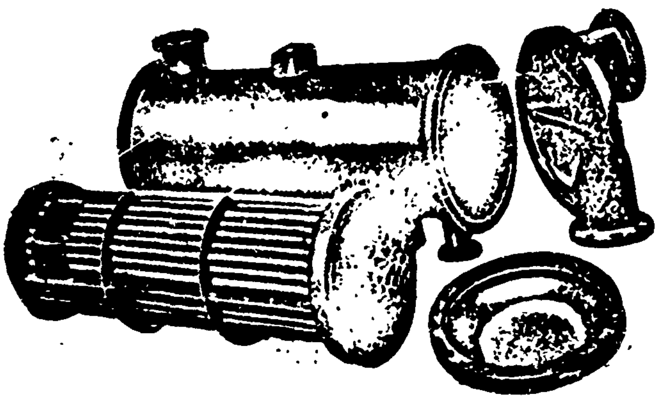

Fig. 1. Graphite heat exchanger.

From a special graphite material - sheet graphite, having perfect casting and mechanical properties, can be prepared a large size apparatus, as well as articles of complex configuration by the method of cold castings.

Substantially different from the described graphite materials are heat conductive materials, obtained on graphite base, which are characterized by a high filling effect. To them belong materials known under the name of antegmit. Antegmit (ATM-1) - anticorrosion and antifriction heat conductive material, made from phenolformaldehyde resin and graphite, differ from saturated graphites by impermeability, and much lower heat conductivity, but its strength is approximately twice higher than that of saturated graphite. From carbon-graphite materials are manufacturated various devices; details, pipes, lining plates, heat exchange devices (coolers, condensers, evaporators, etc.). In Fig. 1 is shown a graphite heat exchanger.

A majority of polymeric materials have low mechanical strength. That is why their use is limited, although from sheet vinyl are prepared

vers, complex equipment (Figs. 2 and 3), from faolite columns, pumps. etc., (Figs. 4 and 5).

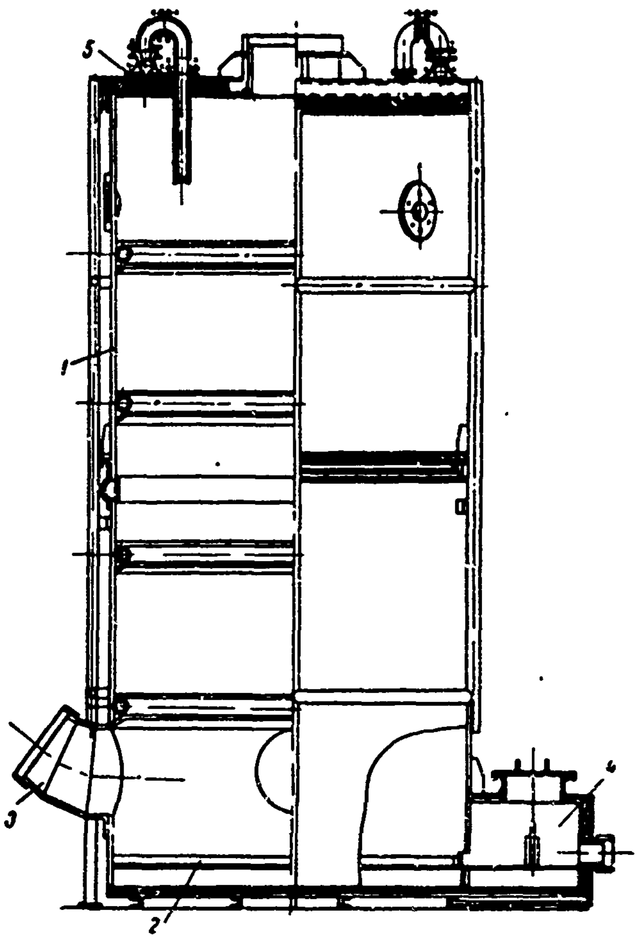

Fig. 2. General view of a moistening tower from sheet vinyl. 1 – body of sheet vinyl tower thickness 5 mm; 2 – bottom of tower; 3 – gas entry; 4 – acid box; 5 – tower lid.

To raise the mechanical strength, especially of thermoplastic materials (sheet vinyl, polyethylene and others), can be done by reinforcement. At the present time was developed a method of lining metal pipes with thermolayers.

Thermoplastic pipes, thanks to strength and rigid shell, can be well preserved under conditions of aggressive media effects at

Fig. 3. Sheet vinyl valve.

much higher temperatures and pressures, then nonreinforced pipes. And so, sheet vinyl reinforced pipes withstand successfully at a temperature of 100°C. In the USSR was organized an industrial undertaking of metal pipes, lined with prestressed sheet vinyl pipes, at the Pervourals old pipe plant and at the pipe rolling plant named after V. I. Lenin at Dnepropetrovsk. In Fig. 6 is given an outline of a bent lined pipe and in Fig. 7 – disassembling connections of lined pipes.

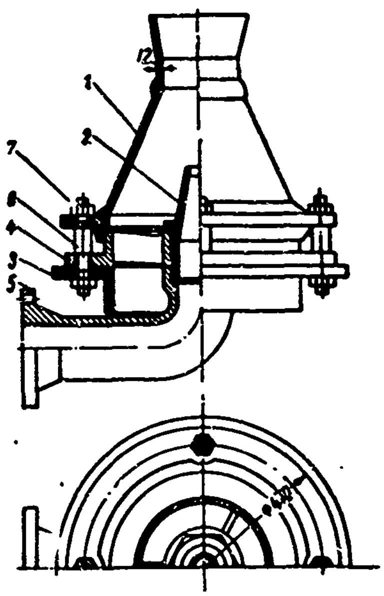

Fig. 4. Agitator for faolite saturator; 1 – body; 2 – nozzle; 3 – support; 4 – ring; 5 – knee; 6 – pin; 7 – nut M-18.

Of greater interest are the new plastics, prepared on the basis of glass fibers and various polymerization and polycondensation resins – glass plastics or glass textolites. The strength of some of the glass plastics reaches 5000 kgf/cm^2. In the USSR an effort is made of using glass plastic pipes, derived on the basis of phenolformaldehyde and polyether (polyester) resins. The strength of glass textolites, manufactured on the basis of silicon-organic compounds, is 260°C-2100 kgf/cm^2. At one of the chemical plants ventilators were made from glass plastics, glass plastics were used for outside reinforcement of glass pipes

(by winding). Abroad glass plastics are used for the manufacture of large scale volumes — towers, reservoirs, galvanic baths, etc. The working temperature for glass plastics, obtained on the basis of polyester resins is permitted up to 150°C.

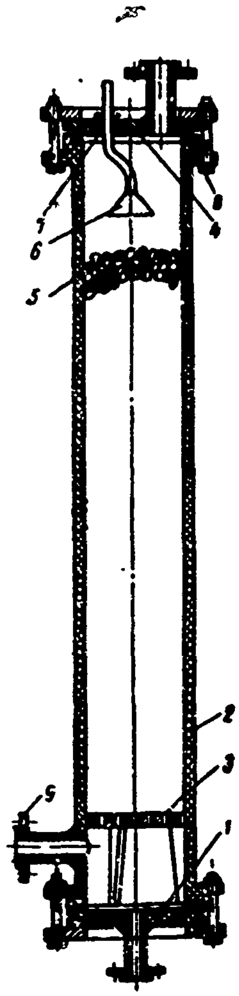

Fig. 5. Faolite column. 1 — bottom; 2 — sheet-steel cylinder; 3 — grat; 4 — lid; 5 — ring fitting; 6 — pipe with funnel; 7 — plug; 8 — flange of sheet-steel cylinder, 9 — connecting pipe flange.

From other types of modern polymeric materials, which came into use only recently, should be mentioned plastics, prepared on the basis of epoxy resins, polypropylene and others. Epoxy resins, obtained by the reaction of epichlorohydrin and polyatomic phenoles, combines easily with other high molecular compounds and is independent upon the character and nature of the modifying substances, they possess acid and alkali resistances, heat resistance of up to 110-120°C and an exclusively high adhesion to metal concrete, ceramics and to other materials. Some of these resins harden in combination with thermoreactive resins, others — in combination with polyamide resins. Upon the introduction of special catalysts these resins give coatings, requiring no heating. Epoxy resins have a small shrinkage; objects made from them are free from internal stresses, which allows them to form large size devices.

High chemical stability is possessed by chlorosulphonated polyethylenes — hypalones, used for linings of chemical devices as well as coatings, applied by a brush, by immersion and dusting.

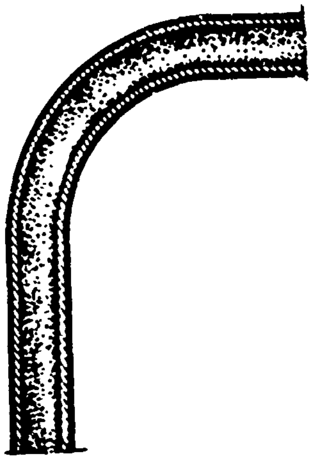

Fig. 6. Bent lined pipe (in outline).

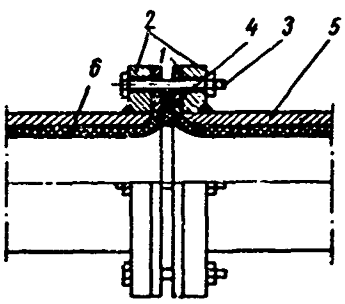

Fig. 7. Detachable flange connection of lined pipes.
1 – sheet vinyl flange; 2 – metal flange; 3 – bolt; 4 – acid and alkali resistant ring; 5 – steel pipe; 6 – sheet vinyl pipe.

Hypalon-20 at room temperature is affected only by fuming nitric acid, carbon tetrachloride, gasoline and nitrobenzene. Thermo- and fire resistance of hypalon allows the same role of coating conveyer belts for the transportation of hot materials.

The highly perspective, polymeric, anticorrosion material, polypropylene is derived from petroleum gases. Its melting point is 170°C; is stable against organic solvents; is 80%-sulfuric acid and caustic sodium; and is frost resistant. Films from polypropylene possess a lower gas permeability than polyethylene films.

There are also other polymers used in anticorrosion technology. Yes, there is data, that nylon is also being used in the role of an individual structural material and in form of films, and liners for the protection of chemical devices against corrosion. The recommended operational temperature of nylon – to 120°C, ultimate tensile strength up to 700-800 kgf/cm^2, resistance to alkalis and diluted mineral acids, alcohols and solvents is high and is affected by phenols, formic acid and certain other media.

In the area of rubberizing, attention is deserving the progressive application method on metal surfaces, rubber mixtures from solutions of liquid polymers, derived on the basis of low molecular chloroprene rubber. These solutions are called in the USSR, Nairit

(chloroprene rubber). Such polymers can give low viscous and with it concentrated solutions (70%) in organic solvents.

This method has considerable advantages in comparison with the existing – gluing around of devices and details with sheets of raw rubber with subsequent vulcanization. A new rubberization method which can be used for the rubberization of details of complex configuration (rotors of ventilators, wheels of centrifugal pumps, spirals, etc.).

Nairit coatings are applied on special grounds (epoxy, etc.). By triple-quadruple application of a Nairit layer and heating at 100°C for a period of 16-20 h in the air at atmospheric pressure there can be obtained seamless homogeneous coatings by dipping, dusting, etc. Within three passages with a brush the thickness of the layer reaches 1 mm. These coatings can be preserved at vacuum as well as under pressure. The upper temperature limit of their application is 70°C, briefly – 90°C. The coatings possess an elasticity and wear resistance, and are suitable in conditions of reaction of mineral acids, alkalines and salts.

These coating had an assured broad application in various branches of national economy, including chemical and general machine construction (for protection against corrosion of galvanic baths, pickling and other installations). Chemical stability of Nairit coatings is no different from the stability of a rubberized layer.

An experimental order was also adopted in the manufacture of liquid thiocol (class of polysulfide rubbers) in the form of a paste. These composition autovulcanize without heating. Thiocol is stable to acids and alkalies, it is benzo- and less stable. Thiocol in a powder form can be applied in metal surfaces by gas flame dusting.

Of paint and varnish materials used for the protection of ferrous metals against corrosion and allowing to replace nonferrous metals and alloyed steels; greater reputation have obtained in recent years epoxy materials which differ by high adhesion, hardness and chemical stability. Coatings obtained on the basis of epoxy resins are widely used for the protection against corrosion of volumes, pipe lines, cisterns, various objects and details of construction. There is data about the possibility of applying epoxy lacquers on a humid surface. Particularly, coatings obtained on the basis of lacquer Э-4100 are recommended for higher moisture conditions, higher temperatures and tropical climate.

Replacement of nonferrous metals in the manufacture of synthetic fibers with paint and varnish coatings for ferrous metals gave a greater economical effect. Investigations of various coatings obtained on the basis of high molecular epoxy resins Э-41, Э-44, Э-49 with the use of organic amines and mineral acids in the role of hardener have shown that epoxy coatings (on the basis of Э-41 and Э-49) possess excellent physicomechanical properties and greater acid resistance.

Paint and varnish materials prepared on the basis of epoxy resin Э-41 differ also in alkaline resistance. Alkaline resistance is characteristic also for perchlorovinyl enamel [KhV-7014] (ХВ-7014), which represents a suspension of pigments and plasticizer in a solution of dry perchlorovinyl resin in organic solvents.

Priming [FL-04] (ФЛ-04) and enamel FL-75, obtained on the basis of phenolformaldehyde resins, are used in the role of benzostable materials for the protection of metal surfaces, subjected to corrosion effect of hot lubricating materials.

Tests of coatings, prepared on the basis of chlorovinyl copolymers with vinyliden chloride ([KhS-04] (ХС-04) and [VKhL-4000] (ВХЛ-4000)

with aluminum powder), have shown a high water resistance, harmlessness and the possibility of being used for painting ship cisterns of drinking water. Anticorrosion enamel KhS-78 and nonovergrowing paint KhS-79, obtained on the basis of a chlorovinyl copolymer with vinylacetate, is suitable for the protection of metal against corrosion and against the effects of sea water.

Paint and varnish coatings, prepared on the basis of modified furyl resins, may find broad application in petroleum refining industry and the role of coating for ferrous metals.

It should be mentioned also the obtainments of recent years in the field of technology and of using and applying polymeric materials in anticorrosion technology. Developed was a new method of dusting plastics on metal surfaces in whirling state. The method consists in that, the heated detail (280-300°C) is submerged in a bath with powder of thermoplastic material (polyethylene and others) intensively mixed by air and the result of which is formed a solid uniformly melted layer of coating.

The All Union Planning-Technological Institute of Heavy Machinery developed the construction and in 1960 started manufacturing a batch of installation (20 units) for the manufacture of objects from glass plastics by the dusting method.

The color in the electrical field represents a new progressive state in the coloring technology. The Montazhkhimzashchita Trust developed a pool method of welding sheet vinyl, widely employed is the method of gluing on roller sticky bands from thermoplasts on a pipe.